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Northern Region

Old-growth Habitats and Associated Wildlife Species in the Northern Rocky Mountains

OLD-GROWTH HABITATS AND ASSOCIATED WILDLIFE SPECIES IN THE NORTHERN ROCKY MOUNTAINS

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INVENTORY AND STAND SELECTION

INTRODUCTION

Old-growth forests are an important component of biological diversity. Old-growth stands are characterized by an increasing variety in sizes and species composition of trees, and more diversity of functions and interactions as compared with earlier successional stages. A complex, multistoried structure and a mosaic of both early and late successional stages often are important attributes (Bormann and Likens 1979). Old-growth forests are not the same as successional climax (habitat type), often being dominated by seral tree species.

The greater vertical and horizontal diversity found within an old-growth stand allows for niche specialization by wildlife. Although the individual wildlife species occurring may not be unique to old-growth stands, the assemblage of wildlife species and the complexity of interactions between them are different than in earlier successional stages.

OLD-GROWTH FORESTS: CONDITIONS IN THE NORTHERN ROCKIES

The Northern Rocky Mountains exhibit very diverse vegetation patterns. In addition to wide gradients in climate and elevation, wildfire has played a major role in the evolution of forest ecosystems in the northern Rockies (Habeck 1987). At the time of European settlement, fire-generated or fire-perpetuated forest types dominated much of the region.

Northern Idaho and northwestern Montana, which experience an inland maritime climate, support near-climax old-growth forests dominated by western redcedar and western hemlock, as well as subclimax old-growth stands dominated by western larch and western white pine. These sites historically burned infrequently, at 100 to 200-year intervals, often by high-intensity stand replacing fires (Habeck 1985).

In west-central Montana, old-growth forests at lower elevations were typically maintained as an open-canopied savanna by frequent (5 to 20-year interval), low intensity ground fires (Arno 1980). These stands were dominated by western larch and ponderosa pine, or by Douglas-fir on moister sites. Recent fire suppression has favored shade-tolerant tree species such as Douglas-fir. At higher elevations, old-growth forests are dominated by true firs and burn less frequently.

In central and eastern Montana, lodgepole pine dominates large acreages. Lodgepole pine stands typically experience frequent, stand-replacing disturbances from fire or insect outbreaks. Along the eastern ecotone between forest and grassland, ponderosa pine and limber pine stands experienced frequent low-intensity fires (Habeck 1988).

DEFINITIONS OF OLD-GROWTH

Attributes of old-growth stands include large-diameter overstory trees, presence of large standing dead and defective trees, presence of down logs, development of a deep duff layer, and formation of canopy gaps and several canopy layers. Several of these attributes may be less apparent in types experiencing frequent fire.

Long periods of time are required to develop old-growth conditions within a stand. However, stand age may not accurately predict the onset of old-growth conditions, because tree species, site conditions, fire or other disturbance, variations in weather, and other factors interact to affect the rate of succession within a stand.

Structural attributes have generally been used as descriptors of old-growth stands. Pfister (1987) attempted to identify existing old-growth stands on the Nez Perce and Kootenai National Forests, using overstory tree size, density of snags, density of down material, canopy closure, and canopy layering. Some of the attributes, particularly snags and down logs, were inadequately sampled. Using stand exam data, Pfister found that few stands met all of the pre-determined criteria for old-growth stands.

The national definition developed by the USDA Forest Service describes old growth conceptually, in terms of plant succession and general characteristics. Ecological classifications are to be developed to define the old-growth community type(s) for each major forest type (or forest type group). Definitions for old-growth communities will be based on vegetation structural characteristics which are easily measured.

OLD-GROWTH INVENTORY

Forest-Wide Inventory. Forest-wide estimates are needed of the relative abundance, patch sizes, and spatial distribution of old-growth habitats by forest type. As a first approximation, *candidate* old-growth habitats should be identified, by stand or groups of stands.

Timber stands are delineated on the basis of predominant overstory species, tree size, and tree density. Contiguous old-growth habitat may be composed of more than one stand.

Data sources for identification of candidate stands could include aerial photographs, satellite imagery, timber stand exam data, Ecodata plot data, and other inventories. Detailed information, particularly on dead trees and down logs, may not be available for each stand. For this reason, additional field analysis of candidate stands may be needed.

Candidate old-growth habitat maps should be updated periodically, to reflect actual old-growth habitat delineations as site-specific inventory information becomes available.

To develop an ecological classification for old-growth community types, data on dominant and indicator species must be collected. The Ocular Macroplot or the Cover Microplot sampling methods (FSH 2090.11) would be suitable for this purpose. The optional Density sampling method can be used to estimate the density of components such as snags and down woody material.

Site-specific Stand Analysis. Stand exam and Ecodata plot sampling methods are recommended to describe vegetation composition, tree characteristics, and structure within a stand. Additional sample plots are needed for components that occur in low densities, such as snags and down woody material.

A general rating of the ability of a given stand to provide old-growth habitat conditions can be made. If the old-growth criteria are used collectively as an "in/out" screen, some stands may be excluded which do in fact have value. Thus, a relative rating system should be used.

Old growth "Scorecards" have been used successfully in various areas. Points are scored for each parameter (such as overstory tree size, number of trees per acre, canopy cover, canopy structure, density of snags and down logs, and decadence) and summed for the stand.

Example scorecards, which are based on judgement rather than data, are shown in Exhibit 1. Scorecards should be refined to reflect local habitat types and conditions. To interpret the meaning of the scoring, comparisons could be made with reference stands (those sampled to develop old-growth community classification).

EXHIBIT 1. EXAMPLE SCORECARD TO ASSESS OLD-GROWTH HABITAT QUALITY

Estimated Parameters - Should be Refined to Reflect Field Data

West-side Mixed Conifer

First rate individual stands:

	Points				Weight	Sum
	0	1	2	3		
Trees per Acre >20" DBH	0-8	9-16	17-24	25+	1	_____
Trees per Acre >30" DBH	0	1-2	3-4	5+	2	_____
Canopy Cover, Polesize and Larger Trees (%)	<40	40-69	90-100	70-89	1	_____
Snags per Acre >20" DBH >15 Ft. Tall	<0.5	0.6-1.9	2.0-2.9	3.0+	2	_____
Down Logs Tons per Acre >10" diameter	<20	20-29	30-39	40+	1	_____
Canopy Layering		one	two	three	1	_____
Decadence (% overstory w/ conks, spike or broken top)	none	1-10%	11-25%	>25%	2	_____
					Stand Score:	_____

Then rate old-growth patch (may include several adjacent stands):

	0	1	2	3	Weight	Sum
Insularity (% of boundary against seedling or sapling stands)	76-100	51-75	26-50	<25%	1	_____
Contiguous Acres	<50	50-80	80-125	>125	2	_____
Patch Shape *	A	B	C	D	1	_____
					Patch Score:	_____

*Patch Shape

A = Linear, narrow
B = Linear, wider than 200 ft.
C = Irregular
D = Circular

East-side Mixed Conifer

First rate individual stands:

	Points 0	1	2	3	Weight	Sum
Trees per Acre >15" DBH	0-5	6-10	11-20	20+	1	____
Trees per Acre >20" DBH	0	1-2	3-4	5+	2	____
Canopy Cover, Polesize and Larger Trees (%)	<30	30-49	50-69	>70	1	____
Snags per Acre >15" DBH >15 Ft. Tall	<0.5	0.5-1.0	1.1-2.0	>2.0	2	____
Down Logs Tons per Acre >10" diameter	<10	10-20	21-30	>30	1	____
Canopy Layering		one	two	three	1	____
Decadence (% overstory w/ conks, spike or broken top)	none	1-10%	11-25%	>25%	2	____
					Stand Score:	____

Then rate old-growth patch (may include several adjacent stands):

Insularity (% of boundary against seedling or sapling stands)	76-100	51-75	26-50	<25%	1	____
Contiguous Acres	<25	25-50	51-80	>125	2	____
Patch Shape *	A	B	C	D	1	____
					Patch Score:	____

*Patch Shape

A = Linear, narrow
B = Linear, wider than 200 ft.
C = Irregular
D = Circular

WILDLIFE SPECIES ASSOCIATED WITH OLD-GROWTH HABITATS

Meslow and Wight (1975) found that 69 percent of the birds occurring in Douglas-fir forest types of the Pacific Northwest used old-growth stands. Three species were listed as nesting primarily within old-growth forests: spotted owl, northern goshawk, and Vaux's swift. Bull (1978) identified six species which are primarily associated with old-growth forests in Oregon: great gray owl, barred owl, flammulated owl, white-headed woodpecker, northern three-toed woodpecker, and Townsend's warbler. The marten is associated with mature and old-growth spruce-fir forests in Idaho (Koehler and Hornocker 1977).

In northwestern Montana, McClelland (1977) described a general trend of increased species richness in cavity-nesting birds from young to old-growth stands of larch and Douglas-fir. Old growth was particularly important in providing an adequate number of suitable nesting trees for cavity-nesters. He also noted the association of open-nesters such as the pine grosbeak, Townsend's warbler, varied thrush, black-headed grosbeak, and goshawk with old-growth forests, as well as its value as big game thermal cover.

Based on a literature review, about 40 percent of the 373 wildlife species occuring in the Northern Region were thought to use old-growth forest for feeding and/or reproduction (Harger 1978). Of these, 33 species were thought to be closely associated with old-growth habitats (Table 1).

The following describes the importance to wildlife of various components of old-growth habitats.

Overstory Trees. Large trees are needed to provide suitable nesting sites for large birds. Bark crevices in older trees provide important foraging sites. Large-canopied trees can modify microclimate by providing shade, capturing moisture, and moderating winds.

Dead and Defective Trees. Dead trees (snags) and defective trees (partially dead, spike top, broken top) provide nesting and roosting sites for cavity-users. Snags host invertebrates which are an important food source for woodpeckers.

Down Woody Material. Downfall supports insects and other invertebrates, provides habitat for fungi and saprophytic plants, provides cover and den sites for wildlife, and creates debris dams in streams. Dead woody material holds moisture and contributes to nutrient cycling. In areas with high frequency of fire, this component will be less abundant.

Tree Canopy. A relatively closed canopy, often with two or more layers, creates a more moderate microclimate. Vertical diversity provides a variety of substrates for feeding or nesting, and supports development of forest components such as arboreal lichens.

Decadence. Presence of heart rot, mistletoe, dead or broken tree tops, diseased trees, and saprophytic plants create a variety of microsites and food sources for wildlife.

MANAGEMENT INDICATOR SPECIES

The National Forest Management Act and its implementing regulations require that fish and wildlife habitats be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area. In order to estimate the effects of each Forest Plan alternative on fish and wildlife populations, Management Indicator Species (MIS) are to be selected.

Table 1. Species in the Northern Region (north Idaho, Montana, North Dakota, and South Dakota) thought to prefer old-growth components for breeding or feeding (from Harger 1978).

WILDLIFE SPECIES	STRUCTURAL STAGES Breed	Feed	OPTIMUM COVER TYPE
Great Blue Heron	5-6	1	ASP, COT
Northern Goshawk	5-6	3-6	ASP, DF, PP, LPP
Great Gray Owl	6	1	LPP, SAF, SP
Flammulated Owl	5-6	1-2	PP, DF, GF, LPP
Pygmy Owl	5-6	1-6	PP, DF, GF, WL
Saw-whet Owl	5-6	1-6	PP, DF, GF, LPP, SAF, SP
Boreal Owl	5-6	1-6	PP, ASP, SP, SAF, DF
Barred Owl	5-6	3-6	COT, DF, GF
Vaux's Swift	5-6	1-6	ASP, COT, DF, WRC
White-headed Woodpecker	4-6	4-6	PP, WWP
Pileated Woodpecker	4-6	3-6	COT, PP, WL, GF
Three-Toed Woodpecker	4-6	3-6	SAF, WBP
Black-backed Woodpecker	4-6	3-6	PP, DF, WWP
Red-naped Sapsucker	4-6	1-6	BGA, COT
Williamson's Sapsucker	4-6	2-6	PP, WL, GF, SAF, SP
White-breasted Nuthatch	4-6	3-6	PP, DF
Red-breasted Nuthatch	4-6	3-6	PP, ASP, LPP, SAF, SP
Pygmy Nuthatch	4-6	3-6	PP, DF
Brown Creeper	4-6	3-6	DF, LPP, SP, SAF
Great Crested Flycatcher	4-6	2-4	BGA, COT
Hermit Thrush	5-6	2-6	GF, WH, WRC, SAF, SP
Varied Thrush	5-6	2-6	WH, WRC, SP
Townsend's Warbler	4-6	2-6	ASP, COT, PP, DF
Silver-haired Bat	3-6	1-3	PP, DF, WRC, SP
Long-eared Bat	4-6	1-6	PP, DF, GF
Long-legged Myotis	4-6	1-6	LPP, SAF, SP
California Myotis	4-6	1-6	BGA, COT, PP, JPU
Fisher	5-6	3-6	ASP, COT, PP, DF, WWP
Marten	5-6	2-6	LPP, SAF, SP, WRC
Wolverine	3-6	1-6	SAF, WBP
Woodland Caribou	5-6	5-6	SAF, SP, WH, WBP
Boreal Red-back Vole	4-6	4-6	SAF
Northern Flying Squirrel	5-6	5-6	ASP, COT, DF, WWP, SAF

Structural Stages: 1=Grass/Forb, 2=Shrub/Seedling, 3=Pole Trees, 4=Young Trees, 5=Mature Trees, 6=Old-Growth

Cover Types: ASP=Aspen, BGA=Birch/Green Ash, COT=Cottonwood, DF=Douglas-fir, GF=Grand Fir, JPU=Juniper, LPP=Lodgepole Pine, LP=Limber Pine, PP=Ponderosa Pine, SAF=Subalpine Fir, SP=Spruce, WH=Western Hemlock, WL=Western Larch, WRC=Western Redcedar, WWP=Western White Pine, WBP=Whitebark Pine

Several categories of species are to be represented where appropriate: Endangered and threatened plant and animal species; species with special habitat needs that may be influenced significantly by planned management programs; species commonly hunted, fished or trapped; non-game species of special interest; and plant or animal species selected because their population changes are believed to indicate the effects of management activities on other species of selected major biological communities (36 CFR 219.19). The first four categories of MIS include "featured species", wherein management activities are directed to providing specific habitat components to meet management objectives for the individual species. The latter category is intended to include ecological indicators, which are selected to represent a larger community of species.

An ecological indicator will ensure the welfare of only those species whose niches are entirely included within its habitat niche and geographic range. To be effective, then, an ecological indicator should have a large home range and be closely associated with a specific habitat.

The goshawk, pileated woodpecker, and marten were identified as MIS by most Forests in the Northern Region to be used as ecological indicators for old-growth components or old-growth habitats. Each of these species have habitat requirements related to stand structure or components which are more likely to be found in old-growth habitats. Their population densities generally are higher in old-growth than in younger stands. In a California study, both marten and pileated woodpecker were found to be sensitive to habitat fragmentation (Rosenberg and Raphael 1986). Each of these species utilize a relatively large home range, which is thought to include the home ranges of other old-growth-associated species.

The habitat requirements of pileated woodpecker, goshawk, and marten, and models for assessing habitat suitability for each are detailed in subsequent sections. Although Schroeder (1987) identified several problems in HSI modeling, they are the most expedient method for evaluating impacts of habitat change.

The requirements of these species in terms of the size and spacing of habitat patches can be used to determine the distribution of old-growth habitats across the landscape.

OLD-GROWTH STAND SELECTION

Landscape Ecology Theory. Forman and Godron (1981) defined landscape patches as communities surrounded by a matrix with a dissimilar community structure or composition. They hypothesized that species diversity within a patch is a function of habitat diversity, disturbance, area, age, surrounding heterogeneity, isolation, and boundary discreteness.

Old-growth habitats offer comparatively high within-stand structural diversity. As forest management progresses through time, old-growth forests will be represented as remnant patches embedded in a younger-aged matrix.

Patch size correlates strongly with the numbers of species and individuals that can be supported and with rates of extinction and recolonization (May 1975, Simberloff and Aberle 1982). Patch size is particularly significant for large, wide-ranging species (Noss and Harris 1986). As acreage decreases, habitat patches become unsuitable for wildlife species with large home ranges. Of 48 old-growth-associated species occurring in the Northern Region, about 60 percent are thought to require stands larger than 80 acres (Harger 1978).

Patch size is modified by its shape due to edge effect. Changes in temperature, humidity, light, and wind, which influence plant species composition, can occur in a band along the ecotone (edge) (Greene 1988). In Douglas-fir old-growth forest, a circular-shaped stand smaller than 25 acres is effectively all "edge" (influenced by the ecotone); within a stand of 80 acres, half of the patch provides "interior" conditions (Lemkuhl and Ruggerio in prep.). In northern California, Rosenberg and Raphael (1986) found that old-growth Douglas-fir stands of less than 50 acres tended to lack the full complement of vertebrate wildlife, and suggested that isolated stands should exceed 125 acres in size to be effective. Wilcove et al. (1986) estimated that habitat islands should exceed 250 acres to provide for birds inhabiting forest interior.

The abruptness of the edge, or edge contrast, affects stand insularity. Edges between similar cover types and successional stages cause less isolation than do edges between very dissimilar stands. A patch totally surrounded by dissimilar habitat becomes more similar to a true island, with less movement of species between patch and matrix (Forman and Godron 1981).

Selection of Stands to Manage for Old-Growth Conditions. The recommended scale for initial analysis of the quality and distribution of existing old-growth habitats is the watershed scale (typically about 10,000 acres in size). Individual stands or groups of contiguous stands can be evaluated using a scorecard method. The habitat requirements and dispersal capabilities of old-growth Management Indicator Species should be used to determine the size, shape and spacing of old-growth patches across the forest landscape.

If a particular analysis unit does not contain existing stands of high quality, large enough size, or sufficient overall acreage, the best available (nearest to old-growth condition) stands should be selected. Alternatively, old-growth stands in adjacent watersheds could be selected, provided the spacing of old-growth patches does not exceed the mobility of the MIS.

Roads are generally undesirable within an old-growth habitat patch. The road corridor fragments the habitat by creating edge, and access may result in loss of snags to woodcutting.

Landres et al. (1988) point out that selecting old-growth stands based on within-patch habitat conditions required by the MIS, and then predicting or monitoring habitat conditions for those MIS, is circular reasoning. Because old-growth-associated MIS are intended to represent a community of wildlife species, stand selection and management should not be directed only towards providing the minimum characteristics required by the individual species. Management objectives and actions in the selected old-growth patches should be directed towards protecting or enhancing the integrity and longevity of old-growth conditions.

In devising a conservation strategy, Forman and Godron (1981:738) emphasize the importance of recognizing that "no patch stands alone", but is influenced by surrounding patches. Harris (1984) recommended surrounding old-growth habitat islands with a long-rotation management area, and interconnecting these with riparian corridors and other linkages. Similarly, Noss and Harris (1986) suggest that a regional landscape level be used, wherein high-quality nodes, such as an old-growth patch, would be integrated within interconnected "multiple-use modules", where management activities are scheduled to maintain the integrity of the nodes.

Natural disturbance regimes such as fire often occur on a spatial scale larger than a landscape patch (Urban et al. 1987). Providing for well-distributed habitat patches with interconnections between patches thus are necessary to maintain species diversity over the long term.

Pileated Woodpecker Habitat Relationships

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Revised by Nancy Warren, Karen Wilson, Mike Hillis, Bob Summerfield, Carl Frounfelker, Tom Wittinger, and Wally Murphy

INTRODUCTION

The pileated woodpecker requires tall, large-diameter dead or live defective trees within forest stands for nesting. It is particularly characteristic of old-growth stands of ponderosa pine, western larch, and black cottonwood stands.

Most of the Forests in the Northern Region have selected the pileated woodpecker as a Management Indicator Species for old-growth habitats. The following describes habitat requirements of the pileated woodpecker, a model to evaluate habitat suitability, and recommended methods for inventory and monitoring of habitats and populations.

ECOLOGY OF THE PILEATED WOODPECKER

Distribution. The pileated woodpecker (*Dryocopus pileatus*) is a year-round resident of forested areas in the northern Rockies. This large woodpecker is absent from the central and southern Rockies (Bent 1964), probably due to the absence of dense highly productive forests in those regions (Bock and Lepthien 1975).

Reproduction. Courtship usually begins in mid-March. Both drumming and vocalizations are used by the male to attract a mate. Pileateds regularly begin breeding as one-year olds, and virtually all birds breed every year (Bull 1987).

One or more new cavities are excavated during courtship each year, within the heartwood of a tree. The distance between successive nests used by the same pair averaged 0.3 mile (0 - 1 mile) in Oregon (Bull 1987).

Clutch size is typically four. The incubation period, usually occurring in May, is about 18 days. The nestlings fledge about one month after hatching. Usually 2-3 young fledge from a nest.

Birds that were banded as nestlings and later nested withing the same study area in Oregon (Bull 1987) dispersed an average of two miles (0 - 5.2 miles).

Nesting Habitat. Typical pileated nest stand conditions can best be described as old-growth stands with a decadent overstory of western larch, ponderosa pine, black cottonwood, or aspen. Stands of 50 to 100 contiguous acres, generally below 5000 feet in elevation, with basal areas of 100-125 square feet per acre and a relatively closed canopy, were used for nesting (McClelland 1977, 1979a, Bull 1980). The grand fir cover type was preferred in Oregon and western larch/Douglas-fir cover types are preferred in Montana (Bull 1987, McClelland et al. 1979).

Nests in the northern Rocky Mountains most commonly occur in dead ponderosa pine, dead black cottonwood, or live or dead western larch trees. Nest trees average nearly 30 inches in diameter, and are more than 91 feet tall in Montana (Aney and McClelland 1985). Minimum nest tree diameter is 20 inches dbh. Nest cavities usually are located more than 30 feet above the ground, at a level within the canopy of the surrounding forest (McClelland 1979a, Bull 1980).

Heart rot appears to be an important feature of suitable nest trees. Decay fungi (*Laricifomes laracis* or *Phellinus pini*) enter the heartwood of living or dead larch trees through a broken top, fire scar, or other wound; decay gradually softens the heartwood while leaving a shell of sound sapwood. Conner et al. (1976), McClelland (1977, 1979a), Mannan et al. (1980), and Harris (1983) all reported a high incidence of broken tops in nest trees.

Pileated woodpeckers are able to excavate cavities in sound wood, however. Bull (1975, 1980) reported that the majority of nest trees in her northeastern Oregon study area, where ponderosa pine was the most common nest tree, showed no evidence of decay at the nest site. This apparently is related to characteristics of the dominant nest tree species of the two regions. Ponderosa pine was the most common nest tree in northeastern Oregon; western larch was predominant in the Montana study. Sound ponderosa pine, with a specific gravity of about 0.37 g/ml, is considerably softer than sound western larch (specific gravity of 0.48-0.52 g/ml). Decayed western larch heartwood, however, is softer than sound pine wood (0.27 g/ml) (McClelland 1977, Harris 1983).

In the Northern Region, either live or dead larch trees can be suitable nest trees, if heart rot is present. Ponderosa pine trees need not have decay at the nest site, but the excavated portion of the bole must be dead. Nest excavation in black cottonwood occurs almost always in dead portions of the bole, but the presence of heart rot is not essential (McClelland 1977). Aspen can provide suitable nest sites if trees are large enough.

Food Habits. Pileated woodpeckers feed principally on carpenter ants (*Camponotus herculaneus* and *C. pennsylvanicus* , excavating deep into ant colonies in dead and decaying wood (Sutton 1930, Bent 1964, Hoyt 1957, McClelland 1977, Bull 1980, Miller and Miller 1980). Beal (1911) examined the stomach of one pileated woodpecker and found the remains of more than 2600 ants. Estimates of the proportion of ants in the diet range from 40-60% (Koehler 1981) to 95% (Bull 1987).

Other insects reported in the diet include termites (Isoptera) and beetles (Coleoptera), which are obtained by bark gleaning, scaling, or excavating. In winter, when few insects are available on the boles of trees, pileateds feed principally by excavating.

Fruits and berries form a secondary component of the diet of pileated woodpeckers in the late summer and fall.

Feeding Habitat. Because carpenter ants make up the bulk of the pileated woodpecker's diet, suitable ant habitat is selected for foraging by pileated woodpeckers. These ant colonies occur most often in large snags with advanced decay, the moist decaying butts of live trees, logs greater than 10 in. in diameter, and natural or cut stumps (Cline 1977, Conner et al. 1975, Bull 1980, Bull and Meslow 1977, McClelland 1977, 1979a). Furniss and Carolin (1977) noted that carpenter ants expecially favor fire-scarred and butt-rotted western redcedar trees, and will make extensive use of Douglas-fir, pines, and true firs.

In Montana, carpenter ants were found to select stands of high canopy cover, but ant densities declined as canopy cover increases past 90% (Youngs and Campbell n.d.). Similarly, stands with basal area in the range of 100 sq.ft. per acre were favored over more densely stocked stands (>150 sq.ft. per acre). *C.modoc* densities were positively correlated with dead wood volume in snags and stumps.

McClelland (1977) suggested that availability of food in winter may act as an ecological "bottleneck", limiting northern Rocky Mountain woodpecker populations. Snowpack makes logs and low stumps unavailable to feeding pileated woodpeckers.

McClelland (1979a) noted that pileated woodpeckers usually avoid open areas for feeding, preferring forests with a significant old-growth component and high basal area. Shelterwood cuts and small group selection cuts are suitable, but not preferred, feeding areas. Bull and Meslow (1977) classified preferred feeding habitats as having high densities of snags and logs, dense canopies, and tall ground cover, with more than 10% of the ground area covered by logs. Kilgore (1971) found that reduction of dead and down woody material by fire caused a decline in the use of a giant sequoia forest by pileateds for feeding.

In the northern Rockies, the density of snags and stumps at pileated feeding sites (not throughout the feeding range) averaged 7 per acre (Aney and McClelland 1985). At least 500 acres of suitable feeding habitat is needed within the home range of a pair (McClelland 1979a).

Home Range Size. Nesting pairs of pileated woodpeckers in the northern Rockies often cover 500-1000 ac. in their daily feeding activities (McClelland 1979a). In high-quality habitat in the northern Rockies, densities of 1 pair per 500 acres are not uncommon (McClelland pers. comm.). Bull (1987) estimated a density of one pair per 480 acres in northeastern Oregon, while Mellen (1987) reported an average home range size of 1200 acres for pairs in western Oregon.

Dispersal Distance.

Bull (1987) recorded juvenile dispersal distances of banded nestlings averaging 2 miles. The longest dispersal was 5.2 miles, although areas outside the study area were not searched, eliminating the chance of finding those that dispersed farther than 9.6 miles.

When adult birds lose their mates, they remain on territory. Juvenile dispersers are essential to mate with unpaired territorial adults and to recolonize unoccupied habitats (Bull pers. comm.).

HABITAT SUITABILITY MODEL

Schroeder (1983) developed a pileated woodpecker habitat suitability index model for application across the range of the species. Aney and McClelland (1985) first developed this model, which is based on data from the northern Rocky Mountains.

Model outputs provide a relative rating of habitat quality which is useful for comparison purposes. Model predictions may not correspond with actual population numbers, since only habitat variables are considered.

Applicability

Geographic Area. This model applies to forested stands of the Columbian Highland Province of the northern Rocky Mountains, which includes west-central and northwestern Montana (west of the Continental Divide) and northern Idaho. In Montana, pileated woodpeckers are uncommon east of the Rocky Mountains, and are not known to nest in the extreme southern portions of the state.

Season. Pileated woodpeckers are resident birds, and generally spend the entire year in the same area. This model considers the year round suitability of feeding stands, but concentrates on winter food sources as the limiting factor.

Cover Types. This model applies to forested cover types in the northern Rockies.

Minimum Area. A contiguous area of at least 100 acres of optimal habitat must be present before a stand can provide an opportunity for pileateds to nest. Feeding habitat must also be available within the 1000-acre home range surrounding the nesting core.

Verification Level. This model is based on a review of published and unpublished research dealing with pileated woodpecker habitat associations in the western United States, with emphasis on research from the northern Rocky Mountains. Data collected by B.R. McClelland was used to develop the nesting habitat portion of this model; the feeding habitat portion is based on an analysis of data collected under the supervision of Mike Hillis, Lolo National Forest Wildlife Biologist. The model was revised based on initial testing by Karen Wilson on the Lolo National Forest; further modification and refinement is expected as the result of additional field verification.

Model Variables

Nesting and feeding habitat suitability are treated separately in the model.

Nesting habitat suitability is a function of four variables: one reflecting stand conditions needed for nesting security (canopy cover), two describing the density of potential nest trees (dead or defective trees >20 inches dbh and >60 feet tall, and dead or defective trees >30 inches dbh and >60 feet tall), and one indicating the average size of potential nest sites (dbh). The number of potential nest sites is calculated separately for trees larger than 20 inches dbh and for trees larger than 30 inches dbh, since the size distribution of snags is usually skewed (K.Wilson pers. comm.). Suitable tree species are western larch, ponderosa pine, black cottonwood, and aspen.

Feeding habitat suitability is a function of canopy cover, density of potential winter feeding sites, and average diameter of potential winter feeding sites. Feeding sites include stumps, snags and butt-rotted trees of Douglas-fir, western larch, lodgepole pine, ponderosa pine, spruce, western redcedar, western hemlock, western white pine, black cottonwood, or aspen. Feeding trees must be greater than 10 inches in diameter. Feeding stumps must be taller that 3 feet in height and have a diameter greater than 12 inches.

HABITAT EVALUATION

The value of habitat for pileated woodpecker can be calculated at two spatial scales: stand-level and home range-level.

Stand-level Evaluation. Individual stands can be evaluated as to their quality for nesting or feeding. Simple cubic root equations were originally chosen to represent the relationship between variables. However, in a test of Schroeder's (1983) model, Lancia and Adams (1985) found that an arithmetic mean would perform better becuase of sampling errors typically encountered when measuring snag densities.

Nesting Habitat Value = $[V(Ncc^1) + V(Npa^{20}) + V(Npa^{30}) + V(Ndbh)] / 4$
or $[V(Ncc^2) + V(Npa^{20}) + V(Npa^{30}) + V(Ndbh)] / 4$

Feeding Habitat Value = $[V(Fcc^1) + V(Fpa) + V(Fdbh)] / 3$
or $[V(Fcc^2) + V(Fpa) + V(Fdbh)] / 3$

Where:

$V(Ncc^1)$ =	Canopy cover in western larch nesting stands.
$V(Ncc^2)$ =	Canopy cover in ponderosa pine and black cottonwood nesting stands.
$V(Npa^{20})$ =	Number of potential nesting trees >20" dbh per acre.
$V(Npa^{30})$ =	Number of potential nesting trees >30" dbh per acre.
V(Ndbh) =	Average DBH of potential nest trees larger than 20 inches dbh
$V(Fcc^1)$ =	Canopy cover in feeding stands of western larch, lodgepole pine, western red cedar, spruce, and western white pine.
$V(Fcc^2)$ =	Canopy cover in feeding stands of black cottonwood, ponderosa pine, and Douglas-fir.
V(Fpa) =	Number of potential feeding sites per acre.
V(Fdbh) =	Average diameter of potential feeding sites.

Coefficients describing the relative value of each variable are displayed at the end of this section.

Multiple Stand Evaluation. An area of 500 to 1000 acres represents the home range of a pair. The home range should include 100 contiguous acres (one or more stands) of optimal habitat (nesting index value of 1.0). With suitable conditions (index value of 0.5), 200 acres of nesting habitat would be sufficient.

Once a suitable nest stand is identified, the next step is to evaluate the capability of surrounding stands to provide adequate feeding habitat for a resident pair of birds. An overall assessment of feeding habitat can be calculated as follows:

$$\text{Feeding Habitat-Acres} = \sum_{i=1}^{n} [\text{Acres } i * \text{Feeding Habitat Value } i].$$

Within the home range, at least 500 acres of suitable habitat (feeding index value of at least 0.5) is needed (McClelland 1979). Equivalent habitat could be provided on 250 acres of optimal feeding habitat (all acres having feeding habitat value of 1.0), 500 acres of suitable feeding habitat (stands with feeding habitat value averaging 0.5), or 1000 acres of marginal feeding habitat (stands with feeding habitat value averaging 0.25). Results of this calculation must be interpreted with care, since areas with uniform conditions of suboptimal habitat are indistinguishable from areas with a mix of optimal and unsuitable habitat, the latter being more desirable (Aney and McClelland 1985).

SPATIAL ARRANGEMENT OF HABITAT

Large, contiguous habitat patches are more desirable than small, isolated patches. Often, old-growth habitats will be found along stream courses in linear patterns. To provide suitable pileated woodpecker habitat, strips should be at least 300 feet in width (McClelland 1979a).

Bull (1987) observed average dispersal distances by juveniles of about 2 miles. Suitable habitat areas should be spaced at 2 mile intervals, or at a density of one per 2,500 acres, to allow recolonization of unoccupied habitat by dispersing juveniles.

In fragmented landscapes, it is essential that high-quality breeding habitat be provided, in order to produce sufficient dispersers to maintain population distribution (Bull, pers. comm.).

MODEL VARIABLES

V(Ncc¹): Canopy cover in Western Larch Nesting Stands

Canopy Cover (%):	<30	30-49	50-65	>65
Value:	0	0.4	0.8	1.0

V(Ncc²): Canopy Cover in Ponderosa Pine, Aspen, and Black Cottonwood Nesting Stands

Canopy Cover (%) :	15	15-30	>30
Value :	0.0	0.5	1.0

V(Npa²⁰): Number of Potential Nest Trees Per Acre >20" dbh *(Dead or live defective)*

No. per Acre:	<0.5	0.5-2.0	2.1-4.0	4.1-7.0	>7.0
Value:	0.0	0.1	0.4	0.8	1.0

V(Npa³⁰): Number of Potential Nest Trees Per Acre >30" dbh *(Dead or live defective)*

No. per Acre:	<0.5	0.5-1.0	1.1-3.0	>3.0
Value:	0.0	0.3	0.7	1.0

V(Ndbh): Average size (dbh) of Potential Nest Trees *(Dead or live defective tree greater than 20 inches dbh)*

Diameter (inches):	<20	20-25	26-30	>30
Value:	0.0	0.3	0.7	1.0

V(Fcc¹): Canopy Cover in Feeding Stands of Western Larch, Lodgepole Pine, Western Redcedar, Grand Fir, Spruce, and Western White Pine

Canopy Cover (%):	<30	30-49	50-85	>85
Value:	0.0	0.5	1.0	0.8

V(Fcc²): Canopy Cover in Feeding Stands of Ponderosa Pine, Douglas-fir, Black Cottonwood, and Aspen

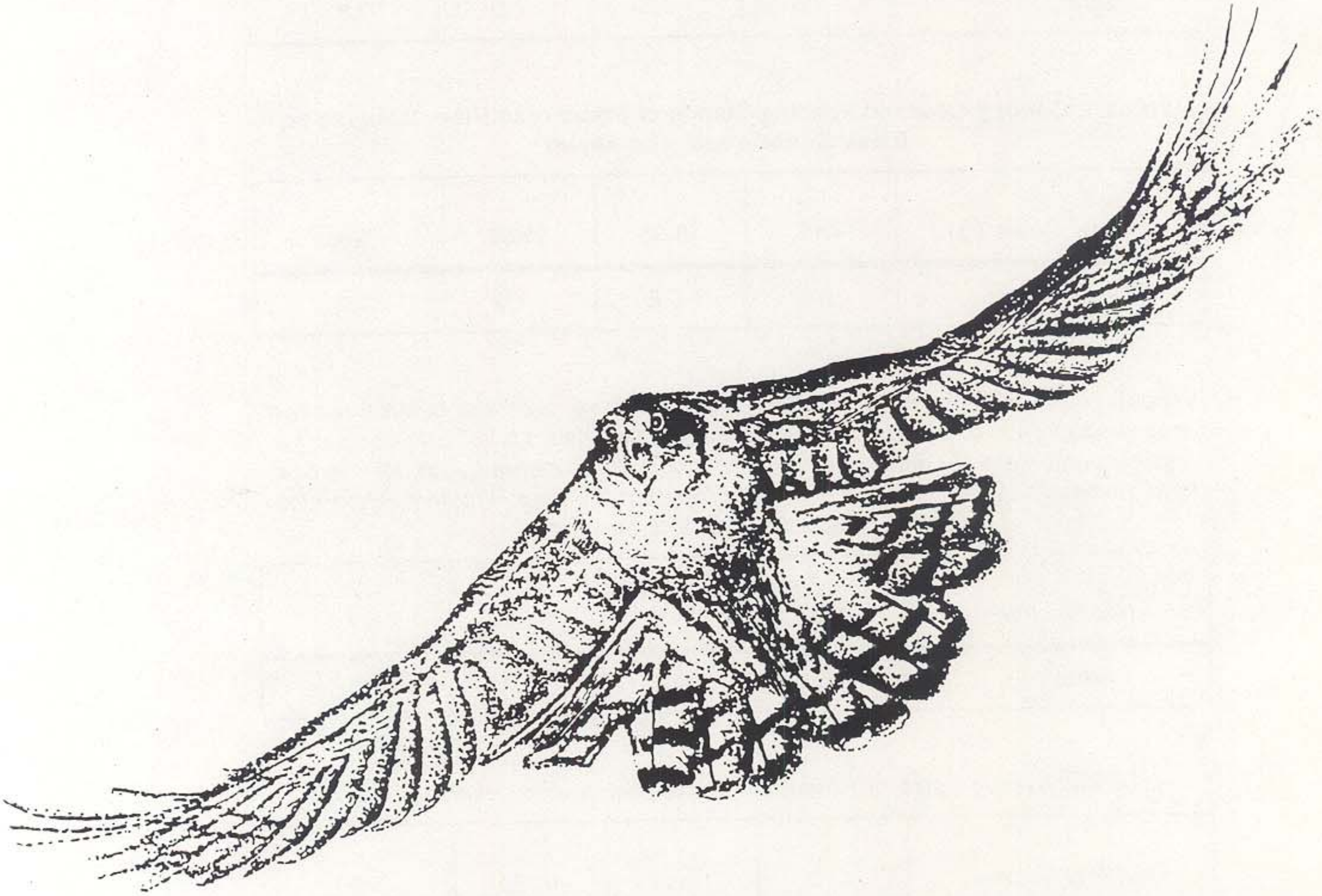
Canopy Cover (%):	<15	15-30	30-85	>85
Value:	0.0	0.5	1.0	0.8

V(Fpa): Number of Potential Feeding Sites per Acre *(Live with butt-rot or dead tree greater than 10 inches dbh, or stumps greater than 3 ft. tall and at least 12 inches in diameter. Suitable species are Douglas-fir, Western Larch, Ponderosa Pine, Lodgepole Pine, Western Redcedar, Western Hemlock, Western White Pine, Spruce, Black Cottonwood, and Aspen.*

No. Per Acre:	<1.0	1.0 - 2.5	2.5 - 7.0	>7.0
Value:	0.0	0.3	0.7	1.0

V(Fdbh): Average size of Potential Feeding Sites *(see definitions above)*

Diameter (inches):	<10	10-15	16-20	>20
Value	0.0	0.3	0.7	1.0



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Goshawk Habitat Relationships

Gregory D. Hayward, Tom Holland, and Ron Escano

Revised by Nancy Warren, Cole Crocker-Bedford, Tom Holland, Tom Komberec, Don Sasse, Linda Saunders-Ogg, and Bill Shuster

INTRODUCTION

Several National Forests in the Northern Region have selected the northern goshawk (*Accipiter gentilis*) as a Management Indicator Species in their Forest Plans. The goshawk is a good indicator of certain types of old-growth habitat, such as park-like forests that experience frequent underburning.

The following describes the habitat relationships of the goshawk and a model which provides an index rating of habitat value.

ECOLOGY OF THE GOSHAWK

Distribution. The goshawk occupies coniferous and mixed forests throughout much of the northern hemisphere (Wattel 1981). Populations are found throughout the coniferous forest of the Northern Region.

Adult goshawks generally are sedentary, remaining on their territory throughout the year (Wikman and Linden 1981, Newton 1979). Goshawks that nest at high elevations in the mountains of western North America may shift to lower elevations in the fall (Mueller and Berger 1967).

Reproduction. Goshawks begin courtship behavior in late March to early April (Reynolds 1975, Hennessy 1978). Although goshawks occupy large home ranges, aggressive territorial defense seems to be limited to the 20-25 acre area around that particular year's nest tree (Reynolds 1983).

In California, an average of 61% of known nests were reported to be active during 1981-83, with annual variation ranging from 49 to 84%. Estimates of the proportion of the population breeding in any given year are difficult to make, due to the use of alternate nests (Bloom et al. 1985).

In both Oregon and California, about 90% of active nests fledged at least one young, and the number of young fledged per active nest averaged about 1.7 (Reynolds and Wight 1978, Bloom et al. 1985).

Peak fledging dates ranged from 20 July until 7 August in northern California (Woodbridge et al. 1985). The fledglings remain in the vicinity of the nest are fed by the adults for another 30-50 days (Reynolds 1975).

Nesting Habitat. Goshawks seem to select for specific structural characteristics in nest trees and nesting stands.

Nest Tree. Goshawks require a nest tree large enough to support the bulky nest structure. The nest is usually placed against the bole of the tree, and is supported by two or three horizontal branches. In the northern Rockies, 17 nest trees averaged 20 inches dbh, with the smallest being 10 inches dbh (Hayward 1983).

Douglas-fir and western larch seem to be the preferred species for nesting in the northern Rockies. Lodgepole pine may be used for nesting when in pure stands (Hayward 1983).

Goshawk nests are typically built within the lower one-third of the crown (Moore 1980). Trees selected by goshawks for nesting usually have an open form, and are adjacent to a small canopy opening which serves as a flight corridor to and from the nest (Hayward 1983).

Goshawk nesting territories include 2-5 nest trees. Alternate nests can usually be found within 325 feet (100 m) of each other, and are almost always within 0.6 mile of each other (Reynolds 1975). Previously-used nest trees are often re-used, even if the nest is no longer intact or evident.

Nest Stands. Throughout western North America, goshawk nest stands consistently have been described as mature to old-growth (Reynolds 1978, Hennessy 1978, Hall 1982, Saunders 1982, Hayward 1983).

The mean canopy cover of 80 percent (measured with spherical densiometer or on aerial photos) surrounding 17 nests in the northern Rockies (Hayward 1983) was very similar to nest sites in northeastern Oregon (Moore 1980), California (Hall 1982), and Arizona (Crocker-Bedford and Chaney 1988). In Utah (Hennessy 1978), canopy cover averaged 63 percent, and in Oregon 61 percent (Reynolds et al. 1982).

Forest stands selected for nesting may be either multi-storied or single-storied, with a relatively open understory (Schnell 1958, Dietzen 1978, Hennessy 1978, Shuster 1980, Hall 1982, Reynolds et al. 1982). Dense understory is believed to make a stand less suitable by inhibiting goshawk flight and providing escape cover for prey species (Reynolds 1978). In the northern Rockies, both single and multi-storied stand structures were used by nesting goshawks (Hayward 1983).

Relatively high basal areas have been recorded at goshawk nest sites in Arizona, California, and Oregon (Moore 1980, Hall 1982, Crocker-Bedford and Chaney 1988). In the northern Rockies, 60 percent of 17 nest stands had basal areas between 160 and 190 ft^2/acre (Hayward 1983).

Goshawk nest stands generally would be considered fully stocked, with moderate to high tree density (Moore 1980, Reynolds et al. 1982, Hall 1982). In the northern Rockies, nest stands had an average of 454 trees/acre larger than 3 inches dbh (Hayward 1983).

Goshawks appear to select nest sites on gentle to moderately steep slopes. In the northern Rockies, slopes of nest stands range from 2-45 percent (average 27 percent), with over 70 percent of nests occurring on the lower one-third or bottom of the slope (Hayward 1983).

Goshawk nests have been reported to occur most frequently on northerly aspects in Utah, Oregon, and California (Hennessey 1978, Reynolds et al. 1982, Hall 1982). In Arizona, Crocker-Bedford and Chaney (1988) found that nests in ponderosa pine types were on northerly aspects, while no difference was observed in mixed conifer forests. In Alaska, nests were found on southerly aspects (McGowan 1975).

Food Habits. Prey items between 200 and 400g appear to be optimum as indicated by mean prey size (Storer 1966, Reynolds 1978, Wikman and Linden 1981). Tree squirrels, ground squirrels, woodpeckers, grouse, jays, and robins are important prey species.

Avian prey items occurred more frequently than mammalian prey in eastern Oregon (54% birds, 42.7% mammals; Reynolds 1978), and in the Sierra Nevada of California (77% birds, 23% mammals; Schnell 1958). Mammalian prey was more important by both number and volume (biomass) in the Coast Range of California (Woodbridge et al. 1985).

Foraging Habitat. The short, rounded wings and long tail of *Accipiter* hawks enables the birds to perform rapid wheeling flights over short distances. Reynolds (1978) indicated that goshawks forage predominantly in the ground-shrub and shrub-canopy zones in forested situations.

Forest habitat, pole stage or larger, which is open enough to allow the goshawk unimpeded flight through the understory, is considered completely suitable for foraging. "Doghair" stands with more than 750 trees/acre, larger than 3 inches dbh, are considered unsuitable foraging habitat (Hayward et al. 1983).

Observations suggest that goshawks hunt forest edges and openings, in addition to hunting within moderate to densely forested stands (Craighead and Craighead 1956, Schnell 1958, Wattel 1973, Fox 1981). Openings are considered fully suitable if all portions of the opening are within 100 yards of an edge; portions of an opening over 500 yards from forest are thought to be unsuitable (Fox 1981).

In Arizona, Crocker-Bedford (pers. comm.) found that goshawk nestling production decreased by 95% following partial cutting, despite leaving buffers averaging 95 acres (range 40-500 acres) around the nests. The harvesting was believed to have adversely affected prey production and availability, and increased competition from Red-tailed Hawks and Great Horned Owls.

Goshawks used plucking posts to dismember and consume prey. Large-diameter snags and stumps are frequently used for this purpose.

Water. Goshawks have been observed bathing during warm weather (Hennessy 1978). Shuster (1980) and Reynolds et al. (1982) suggested that sites near water are preferred for nesting. Open water and moist forest conditions may provide needed protection from heat and sunlight.

Water is not considered to be a limiting factor in boreal coniferous forests of western Montana or northern Idaho. In eatern Montana and in the Dakotas, water availability could be limiting.

Interspersion. Spring-summer goshawk habitat must contain forest stands with suitable structure for nesting, and adjacent foraging habitat with sufficient prey to raise a brood.

In western Montana and northern Idaho (the northern Rockies), over 50 percent of 17 nest sites surveyed were within 0.25 mile of a forest opening (Hayward 1983). However, it was not determined whether these nests occurred near openings through actual nest site selection, or merely reflected typical patterns of vegetation.

Home Range Size. Goshawk territories in the western U.S. have been found 1 to 4 miles apart (Shuster 1976, Dietzen 1978, Hall 1982, Crocker-Bedford and Chaney 1988). In Oregon, Reynolds (1975) measured the average distance between active nest territories as 2.7 miles.

Estimates of breeding population density vary widely. In the western U.S., density estimates range from one pair per 525 acres in Wyoming (Craighead and Craighead 1956); to one per 2,200 acres in Arizona (Crocker-Bedford and Chaney 1988); to one per 3,325 acres in Colorado (Shuster 1976); to one per 6,796 acres in Oregon (Reynolds and Wight 1978).

Dispersal Distance. No data documenting the dispersal distances of juveniles were found.

HABITAT SUITABILITY MODEL

The following documents a model of the habitat relationships of the goshawk. The model provides a relative rating of habitat quality. Population estimates derived from habitat suitability modeling may not correspond to actual population numbers.

Applicability

Geographic Area. This model was developed for application in northern boreal forests within western Montana and northern Idaho, specifically the Columbia Highland and Rocky Mountain Forest Provinces of the Northern Region (Bailey 1978).

Season. Goshawks typically are year-round residents in the northern Rockies. The model was designed to evaluate habitat quality during the nesting season when food demands are highest.

Cover Types. The model applies to coniferous and aspen cover types for breeding and feeding habitat, and non-coniferous cover types for feeding habitat.

Minimum Habitat Area. Potential nesting stands of at least 25 acres (the area defended by breeding birds) must be available. To assess value as potential home range for a pair of goshawks, an area of 5000 acres should be evaluated.

Verification Level. This model is based on published literature, with emphasis on the western U.S. Data collected by Greg Hayward at 17 nest sites in the northern Rockies were relied upon to develop parameters for the nesting habitat portion of the model. Food habitat values based on cover type and structural stage were based on professional judgement, using a Delphi method. The model has been reviewed by goshawk researchers. A preliminary field test on the Idaho Panhandle National Forests indicated that including the variable for nest stand aspect gave misleading results (B.Christensen, pers. comm.), so this variable was dropped from the formula.

Model Variables

Nest stands must have the appropriate structure to allow goshawk movement in and out, offer 2-5 alternate nest trees, and provide a local food source. The important habitat variables for the nesting/cover are considered to be: overstory tree size, canopy closure, size of nest stand, and slope. Canopy closure was judged to be the most important variable.

Assessment of feeding habitat quality addresses availability of tree and ground squirrels, woodpeckers, and large songbirds. Food availability is assumed to be determined by both the abundance of suitable prey and by habitat structure as it influences prey vulnerability. Habitat variables for assessing feeding habitat in forested habitats are cover type, overstory tree size and canopy closure, and snag density. In nonforested habitats, size of opening (acres) is used as an approximate measure of habitat value, assuming that only the edges of large openings are used by goshawks.

HABITAT SUITABILITY EVALUATIONS

Habitat characteristics can be evaluated at various spatial scales. Different variables are important at nest site, nesting stand(s), and home range scales.

Habitat Suitability at Nest Site. Topographic position and aspect appear to be important parameters in nest tree selection. These parameters are useful for focusing field searches for possible nest site locations within suitable nest stands.

Calculation of Habitat Value for a Stand. The nesting/cover and foraging habitat values of a stand are calculated as follows.

Forest:

Cover Value = [{2 * V(cc)} + V(dbh) + V(acres) + (V(slope)] / 5

Food Value = [V(prey) + V(snag)] / 2

Use only V(prey) if snag data are not available.

Meadow:

Cover Value = 0

Food Value = V(open)

Where

V(cc) =	Percent canopy closure
V(dbh) =	Diameter of overstory trees
V(acres) =	Nest stand acres
V(slope) =	Average slope of stand
V(prey) =	Prey production/availability by cover type/ structural stage
V(snag) =	Snags/ acre greater than 10 inches dbh
V(open) =	Size of opening

Charts displaying the suitability values for each variable can be found at the end of this section.

Home Range Habitat Suitability Evaluation. The first step is to determine whether at least two suitable nest stands are available within a 5,000-acre assessment area. (At least two suitable nest stands are required in order to provide alternate sites.) Minimum stand size for nesting is 25 acres, with a patch of at least 125 acres being optimal. Juxtaposition of potential nest stands is important. Suitable conditions exist when the two potential nest stands are within 0.6 mile of each other.

To calculate acres of suitable feeding habitat within a home range, the food values for each stand can be weighted by area (acres) and summed. As a first approximation, at least 3000 suitable acres (average value of 0.5) should be available within the home range. Equivalent acreages would be provided by 1500 acres of optimal (value 1.0) habitat or by 6000 acres of marginal (value of 0.25) habitat.

Cover Index = [2 x (Cover Value(A) + Cover value(B)) + V(distance) / 5]

where (A) and (B) are the two best potential nest stands

Food Index = $\sum_{i=1}^{n}$ [Food Value i * Acres i]

SPATIAL DISTRIBUTION OF GOSHAWK HABITAT

To ensure population viability, habitat must be distributed to ensure genetic interchange and recolonization of unoccupied suitable habitats. Goshawk are highly mobile, but strongly tied to the nesting territory.

No data are available regarding juvenile dispersal distances. Based on reported densities of goshawk in the western United States, suitable habitat for at least one pair should be provided within each approximate 10,000-acre area.

MODEL VARIABLES

V(cc): ***Canopy closure***

% Closure:	0 - 39	40 - 59	60 - 79	> 80
Value:	0.0	0.3	0.8	1.0

V(dbh): ***Overstory Tree Size***

Average DBH:	5 - 9	10 - 14	15 - 20	> 20
Value:	0.0	0.4	0.8	1.0

V(acres): ***Size of Nest Stand*** *(or Contiguous Stands)*

Acres	0 - 24	25 - 50	51 - 80	81 - 125	> 125
Value:	0.0	0.3	0.5	0.7	1.0

V(slope): ***Average Slope Within Nest Stand***

Percent Slope:	< 20	21 - 30	31 - 40	41 - 50	51 - 60	> 60
Value:	1.0	0.9	0.7	0.5	0.1	0.0

V(snag): ***Number of Snags > 10 inches DBH per Acre***

No. per Acre:	0 - 1.0	1.1 - 2.0	2.1 - 6.0	> 6.0
Value:	0.5	0.7	0.9	1.0

V(prey): *Food habitat values*

Values are based on cover type and structural stage, as they influence prey abundance and vulnerability.

Structural stages are defined as follows.

Size / age

1 = Grass / Forb
2 = Shrub/ Sapling
3 = Pole Size Trees
4 = Young Trees
5 = Mature Trees
6 = Old Growth

Canopy Cover

A : < 40%
B : 40 - 70 %
C : > 70%

Structural Stage

	1	2	3A	3B	3C	4A	4B	4C	5A	5B	5C	6
Ponderosa Pine	0.0	0.1	0.2	0.3	0.3	0.3	0.5	0.6	0.4	0.7	0.9	1.0
Lodgepole Pine - Whitebark Pine	0.0	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.2	0.5	0.6	0.7
W. Redcedar - W. Hemlock	0	0.1	0.2	0.3	0.3	0.3	0.4	0.4	0.3	0.7	0.7	1.0
Douglas-fir - Western Larch	0	0.1	0.2	0.3	0.3	0.3	0.5	0.5	0.3	0.5	0.6	0.7
Grand Fir	0.2	0.1	0.2	0.3	0.3	0.3	0.5	0.5	0.3	0.5	0.5	0.3
Subalpine Fir-Spruce	0.3	0.1	0.2	0.3	0.3	0.3	0.5	0.5	0.3	0.5	0.5	0.5
Aspen	0.2	0.4	0.7	0.7	0.4	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Cottonwood - Willow - Alder	0.5	0.5	0.7	0.7	0.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0

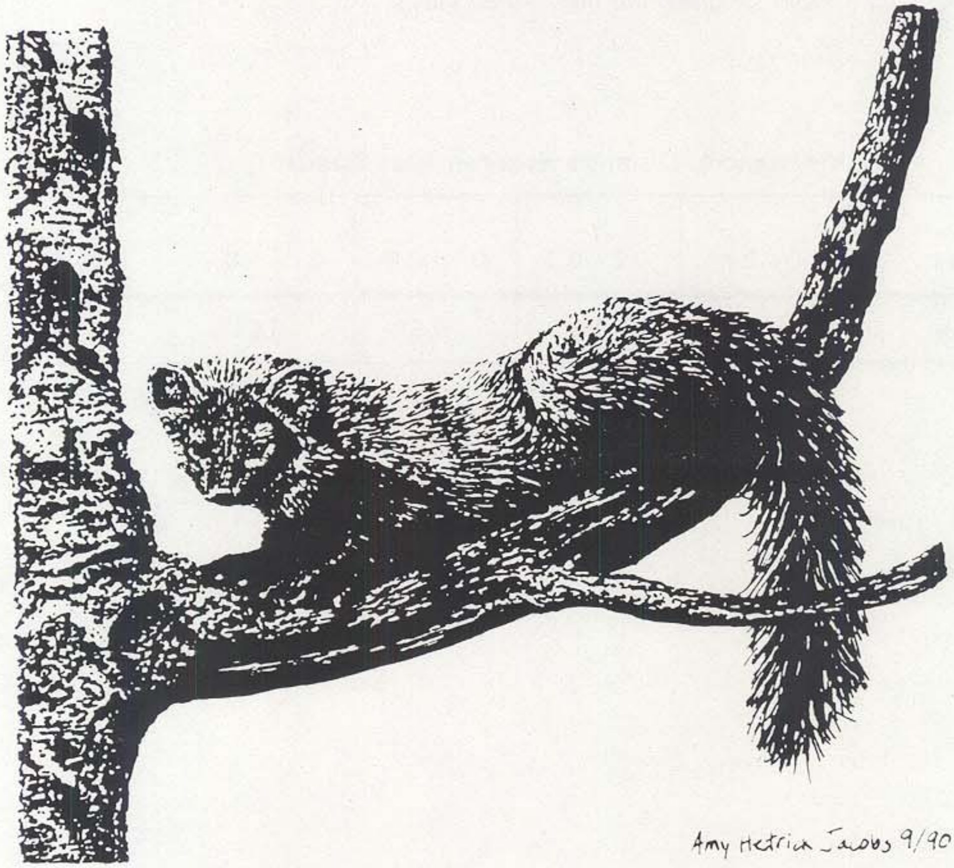
V(opening): *Size of Opening*

Acres	> 5.0	2.0 - 4.9	< 2.0
Value	0.1	0.5	1.0

Note: Size is used as a surrogate for distance to cover. Long narrow openings should be given the next higher value.

V(distance): *Distance Between Nest Stands*

Miles:	0 - 0.1	0.2 - 0.3	0.4 - 0.6	0.7 - 1.0	> 1.0
Value:	1.0	0.8	0.5	0.2	0.0


Amy Hetrick Jacobs 9/90

Marten Habitat Relationships

Tim Patton and Ron Escano

Revised by Nancy Warren

INTRODUCTION

The marten (*Martes americana*) was selected by many of the National Forests in the Northern Region as a Management Indicator Species. It was used to represent species using mature and old-growth habitats, particularly the down woody component.

The following describes the habitat relationships of the marten and a model which provides an index rating of the value of habitat for marten.

ECOLOGY OF THE MARTEN

Distribution. Marten inhabit late successional coniferous forests throughout northern North America in the Canadian and Hudsonian life zones (Marshall 1951, Hagmeier 1956, Strickland et al. 1982). In the western U.S., marten are most abundant in mature to old-growth true fir or spruce-fir forests and generally avoid open, xeric coniferous forests (Weckwerth and Hawley 1962, Koehler and Hornocker 1977, Spencer 1981). The marten is generally nocturnal, and is active throughout the year.

Reproduction. Female marten do not mate until their second year. Litter size ranges from one to four, and kits are whelped in April (Brassard and Bernard 1939). Males do not care for the young.

Denning Habitat. Marten require large snags, stumps, and logs for resting sites and natal dens (Simon 1980, Spencer 1981). Wynne and Sherburne (1984) found that two females with kits used cavity dens until the kits were about eight weeks old; ground logs then were used until the kits were nearly adult size (12-15 weeks).

Food Habits. Microtines, especially red-backed voles (*Clethrionomys gapperi*) and meadow voles (*Microtus pennsylvanicus*), are used more than any other single food item (Cowan and Mackay 1950, Lensink et al. 1955, Weckwerth and Hawley 1962, Koehler and Hornocker 1977, Soutiere 1979). Red squirrel (*Tamiasciurus hudsonicus*), northern flying squirrel (*Glaucomys sabrinus*), and snowshoe hare (*Lepus americanus*) may also be important winter prey (Marshall 1946). In a Montana study, small mammals were the most important food item on an annual basis, with the highest utilization of mammalian prey occurring during the winter months; invertebrates, berries, and passerine birds were the most frequent food items recorded from spring through fall (Weckwerth and Hawley 1962).

Weckwerth and Hawley (1962) believed that fluctuations in small mammal densities in Montana directly affected the carrying capacity of an area for marten. Mech and Rogers (1977) suggested that food availability may be the most important factor limiting marten populations. Thompson and Colgan (1987) found that marten home range sizes were inversely related to food supply.

Feeding Habitat. Koehler and Hornocker (1977) found that mesic coniferous habitat types supported the greatest numbers of rodents. These habitat types therefore would be expected to have high value as marten foraging habitat.

Campbell (1979) reported that winter hunting was confined to dense stands of mature coniferous forest. In Wyoming, Idaho, and Colorado, highest marten activity was recorded in the spruce-fir zone (Yeager and Remington 1956, Koehler and Hornocker 1977, Buskirk et al. 1989). Lodgepole pine stands are used for foraging, if in proximity to old-growth stands (Spencer et al. 1983). In Washington, marten prefer Douglas-fir, cedar and hemlock types, while cedar swamps were frequented more than any other type in Ontario (deVos and Guenther 1952).

In general, marten prefer forest stands with greater than 40 percent tree canopy closure, and avoid those with less than 30 percent (Koehler and Hornocker 1977, Spencer 1981). Stands with less than 30 percent overhead cover, while used very little, were more likely to be used when snow depths were less than 12 inches (Koehler et al. 1975). Overhead cover provides marten with protection from predators, as well as enhancing the mesic conditions favorable for production of voles.

Marten rarely venture more than 150 feet from forest cover, especially in winter (Koehler and Hornocker 1977, Hargis 1981, Spencer 1981). Koehler and Hornocker (1977) believe that openings, which are avoided in the winter, may be used for summer and fall foraging if adequate food and cover are present. Female marten are less likely to cross open areas than are males (Steventon and Major 1982).

Clark and Campbell (1976) suggested that marten winter densities may be limited more by access routes to get at prey below deep snow than the actual density of rodents present. During winter, trees, logs, slash, etc., projecting above the snow provide marten with access to rodents dwelling below the snow (Koehler et al. 1975, Soutiere 1979).

Resting Habitat. Resting sites are usually beneath forest canopy (Simon 1980, Spencer 1981). Closed canopy forest creates a favorable microclimate by reducing snow depth and providing insulation from cold winds. Spruce-fir cover types were preferred resting sites in Wyoming (Raphael pers. comm.).

Large down logs and stumps are especially important in winter for thermal cover (Buskirk et al. 1989). Winter resting sites typically are found under the snow layer, under stumps, snags or logs, and often in squirrel middens (Marshall 1951, Spencer 1981, Steventon and Major 1982, Buskirk 1984).

Water Requirements. The marten's physiological requirements for water remain unknown. Marten concentrate their foraging activities in mesic habitats and near water, probably because of its effects on vegetation structure and prey abundance (Koehler and Hornocker 1977, Spencer 1981).

Security. Marten are easily trapped and are susceptible to overharvest (Soutiere 1979). The effects of road density on marten have not been quantified. Particularly when roads are located through marten travel corridors (ridges, saddles, and riparian zones) and foraging areas, increasing road access is thought to increase the vulnerability of marten to trapping (M.Frisina, pers. comm.)

Home Range Size. Population densities of marten in good habitat generally average about 1 to 3 per square mile (Burke 1982). Home ranges of resident males are distinct, but female home ranges often overlap other female and male ranges (Clark and Campbell 1976, Powell 1979, Burnett 1981).

In Glacier National Park in Montana, mean home range size was estimated to be about 1.0 square mile for resident males and 0.27 square miles for resident females (Hawley and Newby 1957, Burnett 1981). Similar home range sizes were reported in Wyoming (Clark and Campbell 1976). Larger home range sizes have been reported in other areas: for example, Wyoming, 10 square miles for males and 6 for females (Raphael pers. comm.); Minnesota, 6 square miles for males and 1.7 for females (Mech and Rogers 1977); Maine, 3.5 square miles for males and 0.9 for females (Steventon and Major 1982); and California, 1.4 square miles for males and 1.2 for females (Simon 1980, Spencer 1981).

Buskirk and McDonald *(in press)* analyzed variability in home range size as determined by radiotelemetry in 9 separate areas. Home range size varied significantly between the 9 study sites, but showed no obvious geographic pattern (latitude, longitude, elevation, or mean annual temperature range). Mean home range sizes (1160 acres for adult females and 1750 for adult males) are about 3 times that predicted for terrestrial carnivores based on body mass (Linstedt et al. 1986).

Soutiere (1978) reported that home ranges were larger in clearcut forests than in uncut or partially cut forests. Similarly, in Ontario Thompson and Colgan (1987) found that home range sizes were larger in cutover than in uncut forest, and increased during years of scarce food supply. Home range sizes in uncut sites varied from 1.21 to 2.45 square miles for males and from 0.36 to 1.53 square miles for females in years of abundant and scarce food availability, respectively.

Marten home ranges must include resting areas and foraging areas, with adequate cover in close proximity. Marten home range boundaries often coincide with edges of topographic or vegetative features such as large open meadows, burns, or streams (Hawley and Newby 1957).

Dispersal Distances. The dispersal capabilities of marten are not well known, but juveniles have been observed to travel up to 24 miles in order to become permanently established in an adequate home range (Hawley 1955). Jonkel (1959) recorded juvenile movements averaging 9.7 miles for seven males (range 2-25 miles) and 7.5 for four females (range 2-15 miles). An average maximum movement of 6.3 miles was observed by Burnett (1981) for two male and one female non-resident juveniles.

HABITAT SUITABILITY MODEL

This documents a model of the habitat relationships of marten. The model was first drafted by Tim Patton and Ron Escano in 1983. It draws heavily on models develope[illegible] or other areas by Allen (1982), Barrett and Spencer (1982), and Bennett and Samson [illegible]84). Its purpose is to provide a relative rating of habitat value for marten; results may [illegible] correspond with actual population densities.

Applicability

Geographic Area. This model was developed for use within the Columbia Highland and Rocky Mountain Forest Provinces of the Northern Region (Bailey 1978).

Season. This model measures winter habitat suitability. The winter and early spring period is the most critical for marten, due to high energy demands and reduced prey availability. Winter cover requirements are the most seasonally restrictive. It is assumed that if winter habitat requirements are met, habitat requirements during the remainder of the year will not be limiting.

Cover Types. This model is designed to evaluate marten habitat within coniferous habitat types as defined by Pfister et al. (1977) and Cooper et al. (1987) in the Northern Region.

Minimum Habitat Area. Minimum habitat area is the smallest amount of contiguous habitat required before an area will be occupied by resident reproductive marten. Home range sizes of marten are sensitive to habitat quality and food availability. To provide sufficient habitat in scarce food years, this area is thought to be about 3 square miles (1920 acres) of suitable habitat in the northern Rocky Mountains.

Verification Level. The draft model was reviewed by experts in marten habitat relationships (R.Barrett, H.Hash, M.Hornocker, G.Koehler, M.Raphael, S.Buskirk), but has not been field tested.

Model Variables

Assessment of feeding habitat quality focuses on microtine availability because this is the primary winter prey in the Rocky Mountains. Microtine population size is largely determined by the density of herbaceous cover and large woody debris. Overstory tree diameter and canopy cover describe structural characteristics of winter feeding habitat used by marten. The most important variables for assessing feeding habitat quality thus are thought to be soil moisture, density of down logs larger than 6 inches in diameter, overstory tree diameter, and canopy closure.

Winter cover moderates weather conditions, intercepts snow and blocks wind, andprovides protection from predators. The presence of large snags, stumps, and logs increases marten habitat suitability by providing den sites and below-snow hunting access points. Resting and denning habitat are assessed by considering four variables: forest cover type, overstory tree diameter, canopy cover, and density of down logs larger than 10 inches in diameter.

EVALUATION OF HABITAT SUITABILITY

Habitat characteristics and value for marten can be evaluated at two spatial scales. These include stand-level and home range-level scales.

Habitat Value of a Stand. To determine relative value of an individual stand as marten habitat during the winter season, simple quadratic root equations are used as follows:

$$\text{Food Value} = [V(\text{soil}) * V(\text{dbh}) * V(\text{cc}) * V(\text{log})]^2$$

$$\text{Cover Value} = [V(\text{ct}) * V(\text{dbh}) * V(\text{cc}) * V(\text{den})]^2$$

Where:

V(soil) =	Soil moisture, inferred from habitat type
V(dbh) =	Average diameter of overstory trees
V(cc) =	Canopy closure
V(log) =	Density of foraging logs (>6 inches diameter)
V(den) =	Density of potential den sites (>10 inch diameter logs)
V(ct) =	Forest cover type.

Charts displaying the habitat value coefficients for each of the habitat variables (soil moisture, overstory tree size, canopy closure, down log density, forest cover type, and density of potential denning logs) can be found at the end of this section.

Evaluation of Habitat Suitability within a Home Range. Overall habitat quality should be evaluated within a three-square mile area, the presumed home range of one male and two female marten during years of scarce food supply.

Burke (1982) suggested that at least one-half of the acres of a female marten home range be maintained in mature or old-growth (highly suitable) conditions, while Soutiere (1979) recommended that at least 25 percent of an area be maintained in polesize or larger forest cover. Thus, within a 1920-acre home range area, at least 500 acres should provide suitable denning/cover habitat (value of at least 0.5), and at least 500 additional acres of suitable feeding habitat (value of at least 0.5). It is assumed that fewer acres would be needed if habitat were optimal. For example, equivalent acreages of optimal habitat (value 1.0) would be 250 acres each of feeding and denning/resting habitat.

$$\text{Feeding Habitat-Acres} = \sum_{i=1}^{n} (\text{Food Value}(n) * \text{Acres}(n))$$

$$\text{Cover Habitat-Acres} = \sum_{i=1}^{n} (\text{Cover Value}(n) * \text{Acres}(n))$$

SPATIAL ARRANGEMENT OF MARTEN HABITAT AREAS

To ensure that a viable population of marten is maintained across its range, suitable habitat for individual martens should be distributed geographically in a manner that allows interchange of individuals between habitat patches.

During years of abundant food supply, population densities of marten increase as resident adults use smaller portions of their home ranges. Juveniles and non-residents inhabit the unused portions of the residents' home ranges (Burnett 1981, Thompson and Colgan 1987). This gives the population a reservoir of dispersers that could recolonize unoccupied habitats.

A dispersing individual should have the opportunity to encounter several potential home ranges, in order to locate an unoccupied area. Burnett (1981) suggested that 6 miles was a reasonable estimate of the dispersal radius for both male and female juveniles, based on his observations and other reports in the published literature. Given this dispersal radius and population recruitment rates, he estimated that the annual recolonization rate would be 1 to 2 miles.

MODEL VARIABLES

V(soil): *Soil Moisture as Determined by Habitat Type*

MONTANA (Pfister et al. 1977)		IDAHO (Cooper et al. 1977)	
Wet Soil	**Dry Soil**	**Wet Soil**	**Dry Soil**
PICEA/CLUN	PSME/VACA	ABLA/CLUN	PSME/VACA
PICEA/PHMA	PSME/VAGL	ABLA/CACA	PSME/VAGL
PICEA/GATR	PSME/LIBO	ABLA/STAM	PSME/CARU
PICEA/LIBO	PSME/CARU	ABGR/CLUN	ABLA/VACA
PICEA/EQAR	PSME/SYAL	ABGR/ASCA	ABLA/XETE
THPL/CLUN	PSME/JUCO	TSHE/CLUN	ABLA/MEFE
ABLA/CLUN	PSME/ARCO	TSHE/MEFE	ABLA/VASC
ABLA/GATR	PICEA/VACA	TSHE/ASCA	ABGR/XETE
ABLA/CACA	ABLA/VACA	TSME/STAM	PICO/XETE
ABLA/MEFE	ABLA/LIBO	TSME/MEFE	PICO/VACA
ABLA/VAGL	ABLA/XETE	TSME/CLUN	PICO/VASC
ABLA/ARCO	ABLA/VASC	TSME/XETE	
ABLA/ALSI	ABLA/CAGE	TSME/LUHI	
ABLA/OPHO	ABLA/CARU		
ABLA/LUHI	ABLA-PIAL/VASC		
ABGR/CLUN	ABGR/XETE		
TSME/MEFE	ABGR/LIBO		
TSME/LUHI	PICO/PUTR		
	PICO/VACA		
	PICO/VASC		
	PICO/CARU		
	PICO/LIBO		
	TSME/XETE		

Wet Soil Value = 1.0
Dry Soil Value = 0.4

Other habitat types within the series listed above can be assigned a value of 0.2. Habitat types within other series are assumed to have a value of 0.0, due primarily to their occurrence outside of the usual elevation range of the marten.

V(dbh): *Average Overstory Tree Size*

DBH	< 5.0	5.0 - 8.9	9.0 - 14.9	15.0 - 19.9	> 20.0
Food Value:	0.0	0.2	0.5	0.8	1.0
Den Value:	0.0	0.0	0.3	0.7	1.0

V(cc): *Canopy Closure*

% Canopy Closure:	0 - 30	31 - 50	51 - 70	> 70
Value:	0.0	0.8	1.0	0.8

V(log): *Log Density for Foraging* (>6 inch diameter down logs)

Tons Per Acre:	0 - 5	6 - 10	11 - 20	> 20
Value:	0.0	0.5	0.8	1.0

V(den): *Density of Potential Den Sites* (>10 inch diameter down logs)

Tons Per Acre:	0 - 1	2 - 5	6 - 10	> 10
Value:	0.0	0.5	0.8	1.0

V(ct): *Forest Cover Type*

COVER TYPE	VALUE
Western White Pine	0.2
Douglas-fir/ Larch	0.4
Lodgepole Pine	0.4
Grand Fir	0.5
Western Hemlock	0.6
Douglas-fir	0.7
Western Redcedar	0.8
Spruce/Subalpine Fir	1.0

Amy Herrick Jacobs 9/90

Monitoring Old-Growth Habitats and MIS

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INTRODUCTION

The use of terrestrial vertebrates to indicate the effects of environmental change on wildlife communities has been controversial. Although certain species of birds reach maximum abundance in certain seral stages, extensive overlap in numbers and distribution between seral stages has been observed (Shugart and James 1973, Mannan et al. 1984). Because bird populations may respond to secondary effects, and to other factors not related to habitat. Morrison (1986) suggested that direct measures of changes in habitat would be superior to relying on monitoring of bird populations to detect changes. Zonneveld (1983) pointed out that monitoring indicator populations, rather than the habitat itself, would be most useful to detect the effects of very subtle changes that are difficult to measure or of cumulative processes.

Hutto et al. (1987) drew a distinction between species-oriented and ecosystem-oriented conservation, and pointed out that focusing too closely on individual species may not ensure protection of diversity at higher levels. On the other hand, Meslow (1987) re-iterated the need to provide sufficient amounts of quality habitats for the most restrictive species, and suggested that this would satisfy both species-level and community-level considerations.

Landres et al. (1988) pointed out that identifying old-growth stands based on habitat requirements of the MIS, and then monitoring habitat conditions for those MIS to assess old-growth conditions, is circular reasoning. Because old growth-associated MIS are intended to represent a community of wildlife species, stand selection, management, and monitoring should not be directed only towards the minimum requirements of MIS. Both general habitat conditions in relation to an ecological classification and suitability of the stands or patches to MIS need to be monitored.

Three levels of monitoring intensity have been identifed for Forest Plan implementation: implementation, effectiveness and validation monitoring. Monitoring of habitats should be emphasized at all levels, with additional monitoring of habitat occupancy and population trends of MIS as appropriate.

MONITORING INTENSITY

Implementation Monitoring: *Did we do what we said we were going to do?*

This type of monitoring is key to determining whether the Forest Plan goals, standards, guidelines, and management practices are implemented as planned. The primary focus is on habitat. For example, analysis areas are evaluated to determine whether the prescribed amount, quality, and spacing of old-growth habitat was provided.

Effectiveness Monitoring: *Did the management practice do what we wanted it to do?*

Effectiveness monitoring could include determining whether designated old-growth habitat areas meet the habitat needs of the management indicator species. This will usually be accomplished by using a habitat model to calculate the relative value of a given habitat area.

Model predictions can be tested by sampling a portion of the designated old-growth stands to determine the actual rate of occupancy by management indicator species. To assess habitat occupancy, the following protocols must be observed.

1. The habitat area should be visited during the period when the particular MIS is most easily detected.

2. Stands should be visited more than once if the MIS is not detected. If none are found, this may not mean that the area is unoccupied. For example, fluctuations in breeding effort due to weather or prey density may influence vocalization by goshawks and pileated woodpeckers. Considering only one sample or one year of data probably would result in an underestimate.

3. Unoccupied, apparently suitable stands should be revisited in subsequent years. One-hundred percent occupancy of suitable habitat should not be expected in every year; an unoccupied habitat patch could later be recolonized.

4. Record information on survey areas where no MIS were detected, as well as recording detections.

One caution is that focusing attention only on habitat occupancy could be misleading. Marginally suitable habitats can function as population "sinks", if they are continually occupied (due to proximity to optimal habitats or for other reasons), but fail to support reproduction.

Validation Monitoring: *Were our assumptions and coefficients correct?*

1. Validation of Model

Model validation should include tests to determine whether model output correctly predicts habitat quality. Reproductive performance over time is a good indicator of site productivity.

Each variable should be evaluated as to its correlation with occupancy or reproductive success. Coefficients may need to be adjusted to reflect local conditions; such adjustments should be documented.

2. Validation of Effects of Management Practices on Population Viability

The NFMA regulations require that population trends of Management Indicator Species be monitored and related to habitat management. Monitoring data should enable comparison of "control" and "treatment" territories. Otherwise, it will be unclear whether observed population changes were due to habitat change, weather, prey population cycles, or other factors.

Verner (1983) estimated that, to detect a decline in a bird population of 25 percent, with 20 percent probability of failing to detect an actual decline, about 180 sample points would be required per year. This assumes an average detection rate of 1 per sample point. Achieving this large a sample size probably is infeasible at the Forest level.

Forests should identify 15 to 20 occupied old-growth habitat areas. It would be desirable to have these include a variety of situations, including large relatively undisturbed areas as well as those located within intensively managed portions of the Forest. Annual monitoring of occupancy of those sites will provide data for Regional population trend evaluation.

To monitor the effects of habitat alteration, observations must be continued for several years. For example, during the first breeding season after timber harvest, productivity of goshawk and marten may remain high because tree squirrels temporarily become readily available. In subsequent years, the adults may continue to inhabit the territory, but productivity could decline.

METHODS FOR HABITAT MONITORING

Aerial photo interpretation or other remotely-sensed data are suitable to determine cover type, overstory tree size, percent canopy cover, and stand acreage. Additional sampling effort will be needed to obtain reasonably accurate estimates of size and density of dead trees, standing and down.

Either a fixed plot (circular or belt transect) or circular variable plot methods can be used for field sampling of dead trees. A one-acre size appears to be most efficient for fixed plots, or a Basal Area Factor of 5 for variable plot sampling, when snag density exceeds 0.2 per acre (Bull et al. 1990).

METHODS FOR MONITORING PILEATED WOODPECKER

The usual method to determine presence of pileated woodpeckers is to traverse a stand during the April - June period, listening for calls and looking for newly excavated cavities and large chips under trees and logs (Bull 1987). Pileated woodpeckers often call or drum in the vicinity of the nest tree during the excavation period and when the male and female exchange incubation duties (Kilham 1959).

Nests can be located by looking for cavities and signs of excavation. Pileated Woodpeckers often start a nest hole, than abandon it and excavate a different cavity in a new location (McClelland 1979a). During the incubation period in late May, likely nest sites can be observed in early morning or late evening, when the pair exchanges incubation duties.

Roosts can be found by listening for "cuk" calls in the evening (McClelland 1979a).

A point-count sampling method can be used to inventory a larger area. A survey route is travelled, stopping at 1/2-mile intervals to listen for calling or drumming by pileated woodpeckers. The survey route should be started at daybreak, and completed within 3 hours, to coincide with the period of highest vocal activity of the birds.

Although pileated woodpeckers vocalize spontaneously, the probability of recording a bird that is present in an area possibly may be improved by playing taped calls during the breeding season. Calling stations should be spaced at 1/2 mile intervals, as before. Calls should be played for 2 minutes, followed by a listening period of 3 minutes. Repeat, then move to the next station (Bull and Holthausen *in press*).

METHODS FOR MONITORING GOSHAWK

Nest Searches. The usual approach to goshawk nest searches is to systematically traverse a stand, looking and listening for evidence of goshawk presence or nesting activity. In addition to positive identification through sightings or vocalization, sign such as whitewash, plucking perches, feathers, and prey remains can be used as cues to goshawk presence (Saunders 1982).

Two different vocalizations can be used, depending on when surveying is done. The adult alarm call is most effectively used early in the nesting season (April-May), and after hatching (late May to June). The call is given every 15-20 minutes. After the young have fledged and through August, the begging call of the immature bird can be given in addition to the adult alarm call, at the same intervals. Although the begging call will often elicit a response into the late fall, its effectiveness for locating nests is greatly reduced by early September as the juveniles disperse farther from the nest tree.

Taped calls of goshawks can be used to elicit responses from goshawks as stands are traversed. Tapes can be obtained through the Regional Wildlife Habitat Relationships Program. Goshawks also readily respond to human imitations of their vocalizations.

Surveyors need to be very observant while calling, as birds will often fly to the call

Surveyors need to be very observant while calling, as birds will often fly to the call without immediately responding. Goshawks seem to be antagonized by dogs, so their presence may elicit more responses. Imitation or recordings of Great Horned Owl vocalizations have also been successfully used to elicit adult alarm calls prior to and after incubation.

All areas which are traversed need to be mapped, whether goshawks are located or not. Nests which are found should be mapped, located on aerial photos, and permanently marked to facilitate future monitoring.

Once a nest is found, the area within one quarter of a mile should be searched for alternate nests. One to four alternate nests may exist within the vicinity of any active nest tree (typically within 1/4-mile, up to 6/10-mile). Approximately 100 acres can be surveyed per day, traversing relatively flat terrain. One to 5 person-days may be needed to locate nest trees within an occupied nesting territory.

Sensitivity to Disturbance. Although goshawks show strong nest site tenacity (Reynolds 1975, McGowan 1975), human disturbance or the alteration of forest structure at the nest site can cause abandonment. The risk of nest abandonment as a result of human disturbance is greatest during nest site selection and remains high until hatching (Forsman 1980).

In areas of regular human activity, goshawks may gradually become accustomed to humans and even nest adjacent to human habitation (Hayward, pers. comm.).

METHODS FOR MONITORING MARTEN

The most commonly used methods to determine presence or patterns of abundance of marten include sooted track plates (summer and fall), snow track counts (winter), and live trapping.

Sooted track plate cubbies baited with fish and commercial marten lure have been found to offer a relatively time-efficient means of determining marten presence and habitat use (Barrett and Spencer 1982). Cubbies can be checked and baited periodically to obtain an index of habitat use. However, this method is biased if used over a long period because marten learn the locations of the cubbies and will return to them regularly.

Winter track counts can be used to determine presence of marten. Results of track counts do not correlate directly with population density, although studies are underway to determine whether snow track count data can be calibrated to population size (S.Buskirk, pers. comm.). Winter track counts must be conducted after fresh snowfall, which makes scheduling and logistics difficult.

The success rate of live trapping is probably too low to be useful for monitoring purposes.

Trapper success is not a reliable index of marten abundance due to variations in snow conditions (Thompson and Colgan 1982) and in between-year fluctuations in trapper effort due to changes in fur prices.

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